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Effect of nutrients on growth and yield of ginger under bamboo-based agroforestry system

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Abstract
The experiment was conducted on effect of nutrients on growth and yield of ginger under bamboo-based agroforestry system at IGKV, Raipur, to study the growth and yield performance of ginger with seven various combinations of nutrients, replicated thrice in RBD design. Growth and yield attributing traits were observed in which plant height, number of leaves per tiller, rhizome length, rhizome width, number of fingers, fresh and dry weight of rhizome found significantly maximum in treatment T7 (100% N+50% P+50% K+Azospirillum+Azotobacter+PSB), whereas collar diameter and number of tillers per plant found significantly maximum in treatment T5 (100% N+50% P+ 50% K+ Azospirillum). It was analyzed that, treatment T7 (100% N+50% P+50% K +Azospirillum + Azotobacter +PSB) and T5 (100% N+50% P+ 50% K+ Azospirillum) recorded better growth and yield performance of ginger under bamboo based agro-forestry system with respect to other treatments.

Keywords: Hernia, buffalo bull, umbilical, herniorrhaphy

Introduction
Cultivating trees and agricultural crops in intimate combination with one another is an ancient practice that farmer have used to practice throughout the world. One such combination attributes to Agroforestry, is a brilliant technique that combines century-old wisdom with current science in a system, as well as the principle of thinking small to accomplish potentially large and transformational consequences (Steiner, 2012). It emphasises the use of multiple indigenous trees and shrubs, particularly suitable for low input conditions and fragile environments, it involves the interplay of sociocultural values more than most other land-use systems; and it is structurally and functionally more complex than monoculture. In agroforestry system, higher production might be due to several growth factors like light or water or because of enhanced fertility of soil. It is found that agroforestry is much beneficial than any other systems to farmers either agriculture or forestry (Samra *et al.* 1999) [7]. Bamboo belongs to Poaceae (Gramineae) family, is a fast-growing plant that can thrive in a wide range of climatic and edaphic conditions which includes roughly 1500 species in 87 genera. Because of their numerous economic applications bamboos are known as “green gold”, “poor man's lumber”, “bamboo, friend of the people” and “cradle to coffin timber”. According to Sharma *et al.* (1992) bamboo also conserves soil moisture and reduces the harmful effects of drought on flora and wildlife. The scope of bamboo in agroforestry is particularly broad (Balaji 1991) [1] and are well cultivated under agrisilviculture, silvi-pastoral, agri-silvi-pastoral, and agri-silvi horticultural systems. The intercropping of the present study was Ginger (*Zingiber officinale* Rosc.) which is an important horticultural crop, member of the Zingiberaceae family. Ginger is a shade-loving plant that may be cultivated in conjunction with a variety of trees and can be used as part of several agroforestry concepts (Jaswal *et al*., 1993) [2]. It produces a pungent, aromatic rhizome that is valuable all over the world either as a spice that has been used in cooking or herbal medicine for the carminative and simulative properties of the digestive pathway. Sun dried ginger is mainly put into utilization for production of essential oil, oleoresin, non-alcoholic beverages, and vitamins added drinks. India is the leading producer accounting for around 70% of world production and exporter to more than 50 countries. The present study was conducted in order to study the growth and yield of ginger (*Zingiber officinale*) cultivated with Bamboo plantation in agroforestry system with many combinations of nutrients.

Material and Methods

The field experiment was conducted in the KVK Farm of Indira Gandhi Krishi Vishwavidyalaya Raipur during 2021-22. The experiment was laid out in randomized block design with three replications having seven treatment combinations as given in Table1. The unit plot size and seed to seed distance were 4m x 4m and 60cm x 45cm respectively. Ginger variety Suprabha was taken as a test crop and planted during first week of July. FYM was applied @ 10 t ha-1 at the time of field preparation, while NPK i.e., 100:60:60 kg/ha was given in the form of urea, SSP & muriate of potash. Three biofertilizers namely Azospirillum @ 5kg/ ha., Azotobacter and PSB (Phosphate solubilizing bacteria) @ 20kg/ha were also applied. The fertilizer applied in 3 equal instalments at 30, 60, 90 days of sprouting but started after 15 days of the application of biofertilizer and interval between the splits was same. The cultural practices were followed as per packages and practices of the crop. Data on different growth and other yield parameters were recorded from 9 randomly selected plants from each treatment. The collected data were analyzed statistically and adjusted with least significance (LSD) at 5% level of significance.

Table 1: Different treatment of fertilizer

T1	100% of N fertilizer
T2	100% N + 100% P
T3	100% N + 100% K
T4	100% N + 100% P +100% K
T5	100% N + 50% P + 50% K + Azospirillum
T6	100% N + 50% P + 50% K+ PSB
T7	100% N + 50% P + 50% K + Azospirillum + Azotobacter + PSB

Results and Discussion

Growth parameters

Observation on various growth parameters are given table 1. Height of ginger after 150 days of sowing was recorded maximum in T7 (62.63 cm), and it was statistically at par with T6 (60.53 cm) and T5 (60.05 cm) while minimum plant height was found in T1 (54.48 cm), number of leaves per tillers was maximum in T7 (21.92) and it was statistically at per with T5 (20.95). While minimum number of leaves per tillers was found in T1 (17.06), maximum collar diameter of ginger plant was recorded in T5 (9.04 mm), while T6 (8.83 mm) and T7 (8.78) were statistically at par. The minimum collar diameter was found in T1 (7.63 mm), maximum number of leaves per tillers of ginger plant was observed in T7 (21.92), and was statistically at par with T5 (20.95) whereas minimum number of leaves per tillers was found in T1 (17.06).

Yield parameter of ginger

Observation on yield parameters are given in table 3. The maximum rhizome length was recorded in T7 (19 cm) and T5 (18.33 cm) was statistically at par while minimum rhizome length was found in T1 (13.66), maximum rhizome width was found in T7 (6 cm), while minimum rhizome width was found in T1 (3 cm), maximum number of prime and sub-finger/rhizomes was observed in T7 (3,8 cm) while minimum number of prime and sub- finger was found in T1(1.33,17.06 cm), maximum fresh weight was recorded in T7 (21.6 q/ha), and was statistically at par with T5 (20.56 q/ha) while minimum fresh weight was found in T1 (20.56 q/ha) while maximum dry weight was recorded in T7 (4.65 q/ha) and was statistically at par with T5 (4.38 q/ha) while minimum fresh weight was found in T1 (3.32 q/ha).

Discussion

Effect of nutrients on growth and yield parameters of ginger: Growth attributes recorded at 150 days after planting differed significantly among the different treatments (Table 2.). The data showed that the T7 showed highest plant height (62.63 cm) and no. of leaves per tiller (21.92) while collar diameter (9.04) and no. of tillers per plant (5.33) was higher in T5. It might be due to supply of all the essential mineral nutrients in a balanced amount which results better growth and development. Jyotsna, N. *et al.* (2013) [3] have stated the combine application of biofertilizers significantly improved the vegetative growth of the plant due to production of different growth promoting hormones by microbial activities as well as availability of essential plant nutrients for plant development.

Higher values for yield attributes might be due to increased growth parameters influenced by inorganic fertilizer and biofertilizers. Azospirillum treatments might have led to increase of plant growth by producing growth promoting substances as well as more nitrogen contributed to the soil due to enhanced microbial activities (Selvarajan and Chezhiyan 2001) [8]. Rana and Korla (2010) [5] reported have that Azospirillum increase the yield of ginger crop. This increase may be due to increase in mineralization of organic matter. This resulted in higher uptake of nutrients by plants which increase the rhizome yield.

Effect of shade on growth and yield parameters of ginger

In intercropping ginger perform better than open field condition because it is a shade loving plant. Similar findings were also reported by Safanin *et al.* (1982) [6] in their study and revealed that in intercropping system, micro-cilimate conditions generated by trees enhanced the better growth of under storey crop particularly shade loving crops. Performance of yield of ginger with tree component depends upon availability of moisture, nutrients and light resource sharing between crops and trees. Kumar *et al.* (2001) [4] reported maximum rhizome yield in Ailanthus + ginger than sole crops.

Table 2: Effect of fertilizers and biofertilizers on growth of ginger (150 DAP)

Treatment	Plant height (cm)	No. of leave/tiller	Collar Diameter (mm)	No. of tillers/plant
T1	54.48	17.06	7.63	3.77
T2	58.47	18.84	7.96	4.33
T3	56.99	18.62	8.02	4.33
T4	57.29	19.03	8.15	4.55
T5	60.05	20.95	9.04	5.33
T6	60.53	19.84	8.83	4.88
T7	62.63	21.92	8.78	5.10
S.Em(±)	0.88	0.42	0.20	0.21
C.D. (P=0.05%)	2.74	1.33	0.63	0.66

Table 3: Effect of fertilizers and biofertilizers on yield parameters of ginger

	No. of fingers					
Treatments	**Rhizome length(cm)**	**Rhizome width(cm)**	**Prime finger**	**Sub finger**	**Fresh weight(q/ha)**	**Dry weight (q/ha)**
T1	13.66	3	1.33	4.33	15.70	3.32
T2	15.66	2.33	1.66	3	16.70	3.50
T3	14.66	2.66	1.33	4	17.60	3.63
T4	15.66	2.66	2	5	18.26	3.60
T5	18.33	4.66	2	7.33	20.56	4.38
T6	17	3.66	2.33	6	19.33	4.18
T7	19	6	3	8	21.16	4.65
S.Em(±)	0.29	0.19	0.23	0.28	0.54	0.12
C.D. (P=0.05%)	0.9	0.6	0.73	0.89	1.68	0.37

Conclusion

Application of different combinations of nutrients in bamboo - ginger based agroforestry system have been evaluated. On the basis of present study, it can be concluded that, ginger crop have performed well under bamboo plantation and maximum attributes of growth and yield are significantly improved under T7 (100% N+50% P+50% K + Azospirillum + Azotobacter + PSB).

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